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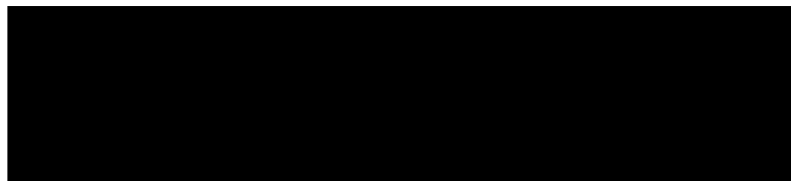
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### *China: Role of Small Plants in Economic Development*

A (ER) 74-60

May 1974

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*China: Role of Small Plants  
in Economic Development*

May 1974



## CHINA: ROLE OF SMALL PLANTS IN ECONOMIC DEVELOPMENT

### SUMMARY AND CONCLUSIONS

China's small plants program has speeded up the modernization of the countryside by broadening the base of important industrial branches—agricultural machinery, chemical fertilizers, cement, hydroelectric power, coal, and iron and steel.

Given China's vast population and inadequate land and capital plant, the program makes sense economically through:

- Provision of additional materials, equipment, and power needed to boost agricultural production;
- Productive use of resources that have meager alternative employment, especially China's huge supply of unskilled and semi-skilled labor;
- Reduction of transport costs;

- Diffusion of capital plant and technology into the countryside; and
- Increase in local control over local economic tasks, which lessens the burden on central administrative resources.

Difficulties with the program stem mainly from overzealous implementation during periods of political upheaval, such as the Leap Forward (1958-60). In addition, even though much of the equipment and materials used in the program comes from local sources, a certain portion must be furnished by the modern sector. Finally, local authorities must make sure that labor is not diverted from the fields at peak planting and harvest time.

Small plants currently contribute to China's industrial output as follows:

Agricultural machinery	Almost all the simple farm tools and a substantial portion of basic farm machinery.
Chemical fertilizers	More than 50% of nitrogen fertilizer output (by weight) and 75% of phosphate fertilizer output (by weight); vital to the agricultural sector, even if not top quality.
Cement	50% of national output; sufficient in quantity and quality for practically all local needs.
Hydroelectric power	About 5% of national electric power capacity and a large part of rural needs, especially for irrigation.
Coal	30% of national output; used mostly for local industry, cooking, and heating.
Iron and steel	20% and 15%, respectively, of national output; used in rural industry and construction.

In addition, small plants furnish an appreciable part of the output of transportation equipment, electronic products, and light industrial products.

Chinese spokesmen tout the small-plants program as a key part of Chairman Mao's general political design:

- The program is an important factor in preventing the dominance of a central elitist bureaucracy;
- It helps reduce the cultural differences between city and countryside;
- It makes feasible the establishment of a vigorous rural economy in contrast to the "drift to the cities" found in other developing countries; and
- It fosters regional self-sufficiency, which is necessary to China's military strategy of defense in depth.

The small-plants program has been administered unevenly over the years. Under the Soviet-style industri-

alization program of the 1950s, small plants were de-emphasized. In the Leap Forward, the frenzied construction of small plants quickly outstripped raw material supplies and administrative capabilities. Most of the small plants were closed down in the retrenchment program of the early 1960s. By the middle of the decade, a more orderly program to build small plants--mainly in support of rural economic development--had been established. At the end of the Cultural Revolution (1966-69), this program had reached boom proportions, and some excesses of the Leap Forward began to reappear. In 1972, China's leaders again re-evaluated and trimmed back the program. The anti-Confucius campaign, which began in January 1974, so far has had no noticeable effect on the small-plants program.

For the foreseeable future, small plants almost certainly will retain their role as an invaluable supplement to modern industry in providing essential commodities to the countryside. Modern industry will remain the cutting edge of China's drive for economic development; small plants will continue their important mission of satisfying demands in the outlying sectors of the economy by making efficient use of growing supplies of low-cost labor and materials.

## DISCUSSION

### Small Plants Defined

In this report, the term *small plants* refers to Chinese enterprises distinguished by a combination of:

- Simple technology,
- Location in rural areas,
- Direct or indirect support to agriculture,
- Dependence on local resources, and
- Local administration (usually below the provincial level).

The plants vary in size from a few workers to a thousand or more, depending on the type of output. The report excludes (a) small plants in urban areas, (b) handicraft establishments, (c) plants that are part of the

new, modern industrial complexes being built in the countryside, and (d) rural plants that are essentially feeder plants to large urban establishments.

According to the official Chinese press, the "five small industries" to be developed in rural areas are agricultural machinery, chemical fertilizers, cement, electric power (mostly hydroelectric), and mining (mostly coal). Iron and steel plants are often brought into these discussions as a sixth category.

This report deals with the economic role of small plants as defined above. The text describes the economic and political advantages of the small-plants program and sketches its historic development. An appendix provides specific detail on each of the six industries featured in the program.

## **Economic Advantages**

### ***Support to Agriculture***

After the near-starvation years of 1959-61, the modern sector of the economy began to support agriculture with large and growing amounts of agricultural implements, irrigation equipment, chemical fertilizers, pesticides, and construction materials. This switch in economic strategy reduced the resources available for investment in industry and for military production. The leadership naturally hoped that a well-organized small-plants program would reduce the drain on the modern sector and would ultimately take over the job of shoring up the agricultural sector.

By 1973, small plants were accounting for about 60% of chemical fertilizer output, 50% of cement, 30% of coal, 15% of steel, and 5% of electric power. This substantial production, all of which was going directly or indirectly to support agriculture, helped agricultural production keep abreast of China's rapidly growing population. In short, the small-plants program has substantially reduced the pressure on China's modern industrial sector and has thereby permitted higher rates of growth in the non-agricultural parts of the economy.

### ***Low Opportunity Costs***

Furthermore, the contribution of small plants has been achieved at low cost in labor and materials. About 85% of China's huge population of some 900 million resides in rural areas. Although labor-intensive methods predominate in agriculture, great numbers of people are available for other work, especially during the slack farming periods. This surplus labor can be used—either full-time or part-time—to operate small mines and industrial plants with little sacrifice of production opportunities in the important farming sphere. Moreover, with the rapid growth in the rural labor force and the gradual mechanization of agriculture, additional labor is continuously becoming available for non-farm activities.

The small plants use large amounts of labor in relation to capital and other resources. Although production per man is low compared with large- and medium-size plants, the use of manpower in this fashion is more productive than in any alternative use—provided that the

program is not pushed to extremes as in the Leap Forward. Machinery is handed down from more modern plants, salvaged from the scrap heap, or put together by local handymen. Local raw materials often are used, materials that perhaps cannot meet the standards of larger plants or that cannot be transported economically over long distances. For example, a small coal mine can be built with gangs of labor, readily available hand tools, and primitive machinery. As coal deposits are widespread in China, most deposits in the hinterland will not be needed for development by the modern sector in the near future. A second example is the construction of hydroelectric plants on streams too small for major projects and the equipping of these plants with machinery handed down from larger installations.

Although the costs in labor, materials, and equipment are generally low—as measured in terms of the best alternative opportunity forgone—in some cases the small-plants program has resulted in substantial costs. The burden of constructing and operating small plants is heavy for local authorities and sometimes reduces administrative and material resources needed for other programs. Whereas the labor devoted to the small-plants program is only about 1% to 2% of the rural labor force as a whole, the percentage in the most advanced areas can reach much higher levels. To assure sufficient labor for agriculture, the authorities now try to limit employment in small plants to 5% of the labor force of the counties. Small-plant activity is reduced during peak periods of agricultural activity and the People's Liberation Army and the cities are called on to supply additional labor. During slack season, maintenance and construction of irrigation systems also require large numbers of workers.

Depending on the branch of industry, small plants compete with modern industry for a portion of their materials and machinery. For example, coal is a major input in the production of chemical fertilizer. Because output of coal is insufficient to supply both small and large fertilizer plants, small fertilizer plants have begun to use local, inferior grades of coal as a substitute for higher grades. Small cement, fertilizer, and hydroelectric plants require equipment from large machine building plants, reducing the amount of equipment that can be supplied to the modern sector. In short, Peking must take into account certain costs—in the form of labor allocation and supplies of raw materials and equipment—in weighing the advantages of small plants.

### *Low Transport Costs*

Integrated industrial groupings are slowly being established at the local level—for example, in the county administrative centers. They encompass a wide variety of industrial activity from mining to production of machinery. Ideally, chemical and steel plants are built near the source of raw materials. Power is made available through construction nearby of small hydroelectric plants and coal mines. Cement and other construction materials also are supplied locally. Because of the short distances between production sectors, most materials can be transported by primitive means—shoulder poles, carts, barges, and occasionally a locally built truck. As the products are used locally, transportation to the consumer can be similarly simple. Other advantages of the close proximity of raw materials, production, and distribution are reduced deterioration of fertilizers (ammonium bicarbonate does not store well, making rapid distribution essential), the ease of administration, and the ready transfer of labor from one occupation to another.

### *Spread of Technology*

The small-plants program speeds up the process of diffusing technology to the countryside. Not only are several million peasants brought into immediate contact with machinery, technology, and industrial discipline, but also the industrial products produced by the small plants are introduced to China's villages in larger volume at an earlier stage. China is unique among the less developed countries in that rural society has been stabilized and a "drift to the cities" prevented. China does not need an influx of ambitious rural youth into the cities, because the urban population of roughly 135 million already provides a vast reservoir of manpower. The government has vowed to decrease the technical gap between the city and countryside. It presumably wants to avoid blighted conditions in rural China experienced in the development process in practically all the developing nations of Latin America, Africa, and Asia.

The process of spreading technology is enhanced by a number of related movements initiated by Mao. The education system, for example, gives impetus to technological training by offering short technical courses on industrial fundamentals. Technicians from large factories are sent to the countryside to train the local workers and

to provide help in setting up plants. The *hsia-fang* (down-to-the-countryside) movement, whereby city students are sent to the villages to be toughened by hard work, adds another dimension to the program—a youthful look from the outside. Similarly, the movement of cadre to the rural areas probably provides new insights into solutions of rural problems. Simultaneously, production brigades are selecting their most likely youth for training in the universities and technical institutes, following which they will be reassigned to their own villages.

### *Administrative Decentralization*

The decentralization associated with the small-plants program has allowed the Chinese government to economize on scarce central administrative resources while providing for local needs. The autonomy at the local level also creates an atmosphere of accomplishment when peasants in a local area combine to set up and operate a simple plant. The ability of the Chinese Communist regime to maintain enthusiasm for production in the absence of large increases in consumption rests on this sense of pride (reinforced by propaganda), as well as on egalitarianism, organizational efficiency, and coercion. Administrative decentralization also is consistent with the need for flexibility in the small-plants program—with respect to hours of operation, sources of raw material, and quality of output. During the Cultural Revolution, when a large part of the government and party apparatus was shattered, the administrative apparatus in the countryside proved entirely adequate to carry on basic economic tasks.

### *Political and Ideological Advantages*

#### *Minimizing Importance of the Bureaucracy*

Small plants figure prominently in Mao's concept of avoiding excessive bureaucracy. Mao excoriates the Soviet leadership for allowing the development of a highly paid bureaucracy which lords it over the workers and peasants. Decentralization of administrative control in China allows local party committees to make operational and policy decisions, thereby reducing the power of central organs. To avoid a slowdown in revolutionary momentum, Mao has proclaimed a number of measures designed to eliminate bureaucratic entrenchment. His motto "Fewer troops, simpler administration" has

meant sizable cuts in the bureaucracy. Sedentary city bureaucrats are sent to "7 May" schools for a few months of physical labor and reindoctrination. Cadres and technicians are assigned to the countryside. The small-plants program fits neatly in with this political philosophy.

#### *Developing the "New Communist Man"*

Mao's concept of the "New Communist Man" is an all-around man, both "red" and "expert," rural and urban, student and teacher. Mao tirelessly advocates the eradication of three differences: between the worker and the peasant, between the city and the countryside, and between mental and manual labor. People are to become technically competent and ideologically motivated to work for the State rather than for the individual. The small-plants program is a means to raise the technological level of the peasants, who are the life blood of Communist influence in China and are seen as more dependable ideologically than urban dwellers.

#### *Insuring Regional Self-Sufficiency*

The Maoist program of regional self-sufficiency is derived from concepts of guerrilla warfare and multiple lines of defense. Each jurisdiction is to develop a comprehensive economic system which can carry on in the event supplies from other areas are cut off. Small plants are an integral part of this picture, being dependent as far as feasible on local manpower, materials, machinery, and administration.

#### **Historical Developments**

##### *Soviet-Style Industrialization*

Until 1958 the Chinese followed the Soviet model of industrialization, with emphasis on heavy industry and on construction of large modern plants. In 1949, small plants (handicraft establishments and other locally operated enterprises) accounted for nearly one-half of China's industrial production. The idea of small-scale industry to support agriculture was advanced but made little headway because planners were preoccupied with grand designs for the economy. In 1957, small plants—producing mostly consumer goods and handicrafts—contributed less than one-third of industrial production.

#### *The Leap Forward*

In the Leap Forward, small plants were assigned a key role in the frantic drive to speed up industrial and agricultural production. The communes, which became the prime rural administrative units in 1958, built 200,000 small industrial plants,<sup>1</sup> and thousands more sprouted up in the cities. Although large amounts of coal, cement, pig iron, and agricultural machinery were produced by these plants, the products were often unusable, and the plants wasted enormous amounts of labor and raw materials.

#### *Readjustment and Recovery*

With the exhaustion of industry, the withdrawal of Soviet technicians, and three successive bad agricultural years, Peking had to abandon the Leap Forward. Resources had to be concentrated on preventing starvation and insuring a minimum flow of industrial goods. To end the hemorrhage of raw materials and the flood of useless output, small plants were closed down by the tens of thousands, and workers returned to the fields.

#### *The Cultural Revolution*

As the economy recovered in the mid-1960s, the small-plants program was gradually revived, mainly to support agriculture. Standardized plants for producing cement and chemical fertilizer were particularly favored. In the late stages of the Cultural Revolution, Mao's political-economic policies once again attained ascendancy. Thousands of small plants were built in both the countryside and the cities in another massive effort to increase output with minimum investment. This effort, however, never achieved the scope, the intensity, or the disastrously wasteful results of the Leap Forward.

#### *Consolidation*

Despite the care with which China's leaders approached the small-plants program following the post-Cultural Revolution, they recognized by 1972 that the program was taking too many resources away from agriculture and modern industry. As a result, the center

1. This figure does not count the 600,000 small backyard "steel" furnaces, which sprung up in urban and rural areas.

tightened control over local construction and local industrial operations. Investment in small plants was cut back. In 1973, press reports on industry as a whole called for (a) increases in production at existing plants, (b) savings of raw materials, (c) solution of technical problems at the local level, (d) cutbacks in administrative staffs, and (e) the primacy of large backbone plants in the production process. Few new small plants were built.

So far in 1974, the anti-Confucius campaign has had no noticeable effect on the small-plants program. A demand for greater self-reliance has arisen during the campaign, and China's dependence on foreign technology has been increasingly criticized. As the campaign unfolds, additional support thus may be given to the small-plants program.

#### Prospects

The small-plants program fits in so harmoniously with China's economic requirements and Maoist political goals that it almost certainly will play a prominent role for the foreseeable future. The following factors guarantee its continuing importance:

- Above all, the continued rapid growth of the labor force and the absence of alternative opportunities for useful employ-

ment of additional workers; even if the population control program cuts the growth rate from 2% to 1%, enormously large numbers will be reaching working age for the next two decades.

- The never-ending process of upgrading the different levels of technology in the economy, starting with modern weapons at the top, through heavy industry, down to small plants, and finally to agriculture and handicrafts; the small plants are a logical link in this transmission process.
- The increasing complexity of the economic problems that must be sorted out by the central leadership; considerable autonomy for small plants and local industrial groupings is essential to the practical management of China's sprawling economy.
- The political and strategic goals of self-reliance and self-sufficiency, which are not likely to be altered, no matter what the character of the post-Mao leadership.

## APPENDIX

### SMALL PLANTS IN VARIOUS INDUSTRIES

Small plants in China are especially important in the agricultural machinery, chemical fertilizer, cement, hydroelectric power, coal, and iron and steel industries. In addition to these industries, this appendix briefly treats small plants in the transportation equipment, electronic products, and light industries.

#### Agricultural Machinery



A Production Team's Grain Processing Center

The machine building facilities established in rural areas are mainly involved in providing equipment for the support of agriculture. Mechanization of agriculture was one of the items incorporated in the National Program for Agricultural Development, 1956-67. The first big push occurred during the Leap Forward with its vast program to build small water control projects and industrial plants. The communes—the supercollectives established as part of the Leap—alone had more than

20,000 factories manufacturing and repairing agricultural machines and implements and 123,000 establishments processing agricultural products. In 1960, 83% of the total investment in capital construction in the farm machinery industry was raised and expended locally.

As in other branches of industry, the rapid expansion of small agricultural machinery plants led to prodigious waste of raw materials and a huge outpouring of crude products. Half of China's farm machinery plants (mostly local plants) were closed down in 1961-63, and the number of workers was cut by two-thirds. By 1963, investment in farm machinery plants had fallen to 16% of the 1960 level, with local investment accounting for only 23% of the total. But the government, as part of its new policy of pouring resources from the modern sector into agriculture, began in 1962 to increase production of farm machinery and equipment in central modern plants—irrigation pumps, tractors, piping, etc. And the best-equipped local plants were retained in operation and continued to turn out a large volume of farm implements.

During and following the Cultural Revolution, a new program was started to advance the pace of agricultural mechanization through use of local resources. Machines and tools were redesigned so that they could be produced in small local plants. Among these products are small pumps, one-man threshers, simple harvesters, rice transplanters, and garden tractors. Some counties reportedly have plants that produce more complicated machinery such as water turbines, diesel engines, and transformers.

Total output from the small agricultural machinery plants cannot be measured from available information. Certainly, it is a useful supplement to the vigorous support given agriculture by China's modern machinery sector. The small plants play a major role in bringing technology to the countryside. The Chinese have reported that 96% of the counties now have their own



County-Run Power Equipment Plant

small farm machinery factories. An increasing number of communes and brigades not only have their own machinery repair shops but also are beginning to produce machines and farm tools.

Many of the machines manufactured by small plants are not built from scratch. Some local facilities are primarily assembly plants, which purchase parts or scavenge them from wornout machines. This is particularly true of repair plants that are said to produce entire machines. Examples are generators produced at power equipment repair plants and trucks produced at auto maintenance plants.

A problem of particular difficulty has been the establishment of a proper balance between production and repair. Plants with a dual role in manufacture and repair have found their greatest profit in turning out new machines and often neglect repair work and the produc-

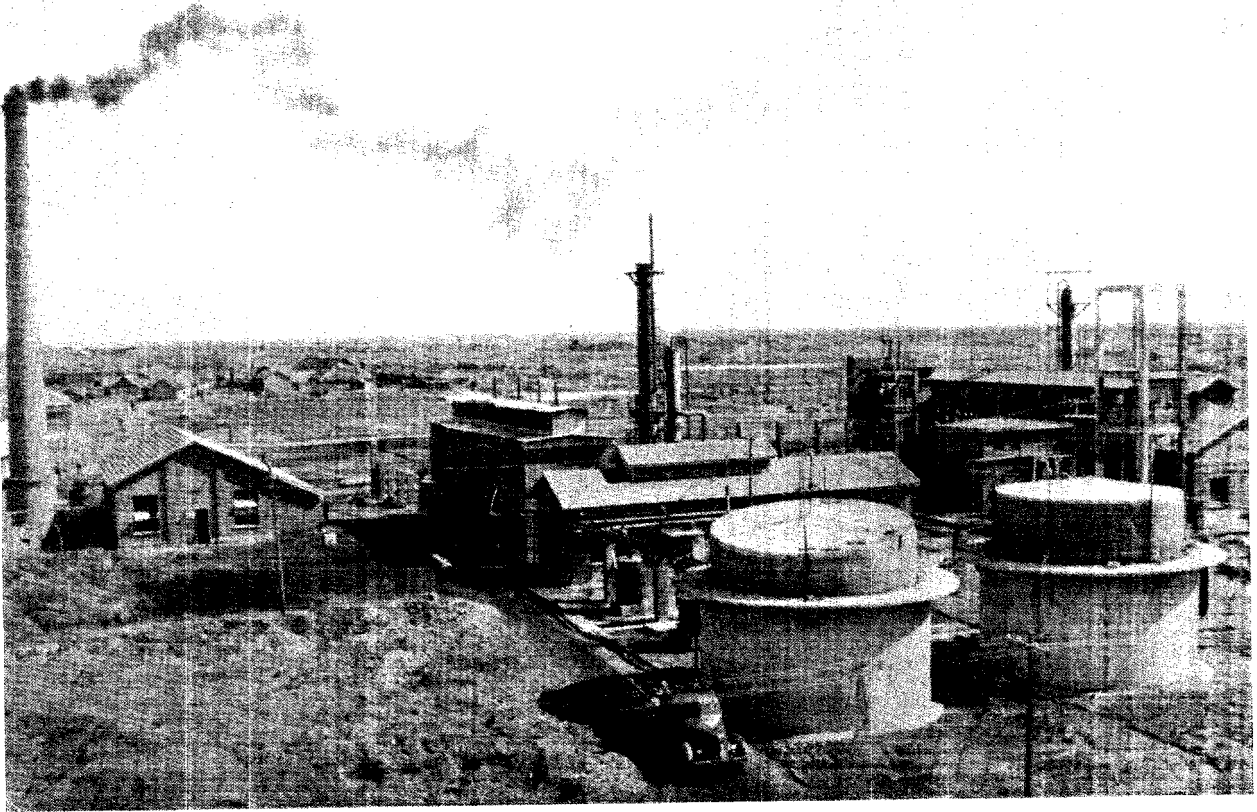
tion of spare parts. The problem is especially serious because locally produced equipment requires frequent repair.

#### Chemical Fertilizer

A hectic attempt to produce fertilizers from small plants during the Leap Forward was successful in producing only small tonnages of useful output. Some production of nitrogen fertilizer was achieved by 1960 after a variety of plants were developed and tested. Programs to produce crude forms of fertilizer such as ammonia water and crushed phosphate rock were largely ineffective.

The Chinese made an important advance in the small-scale production of chemical fertilizer in 1964-65 with the development of a standard plant rated at 3,000-5,000 tons of synthetic ammonia and





Chemical Fertilizer Plant

10,000-15,000 tons of fertilizer annually. The development of the standard plant permitted an increase in the proportion of nitrogen fertilizer produced by small plants from 10% of the national total (by weight) in 1964 to more than 50% in 1973. At present, China has more than 1,000 small nitrogen fertilizer plants. The following tabulation shows the production of nitrogen fertilizer by small plants:

Million Metric Tons			
	Small Plants	Modern Plants	Total
1957	Negl.	0.68	0.68
1958	Negl.	1.01	1.01
1959	Negl.	1.36	1.36
1960	0.17	1.55	1.72

Million Metric Tons			
	Small Plants	Modern Plants	Total
1961	0.21	0.84	1.05
1962	0.06	1.45	1.51
1963	0.16	1.88	2.04
1964	0.24	2.12	2.36
1965	0.37	2.72	3.09
1966	0.50	3.10	3.60
1967	0.41	2.49	2.90
1968	0.69	3.61	4.30
1969	2.38	3.72	6.10
1970	3.31	4.39	7.70
1971	4.17	5.53	9.70
1972	6.12	5.88	12.00
1973	7.89	6.72	14.61

Small phosphate fertilizer plants now number several hundred with an annual output of more than 7.5 million tons—75% of national output by weight. In the recent drive, the Chinese again built numerous tiny plants producing a variety of fertilizer materials such as ammonia water and bacterial fertilizers. These contribute only a minor portion of total effective fertilizer output.

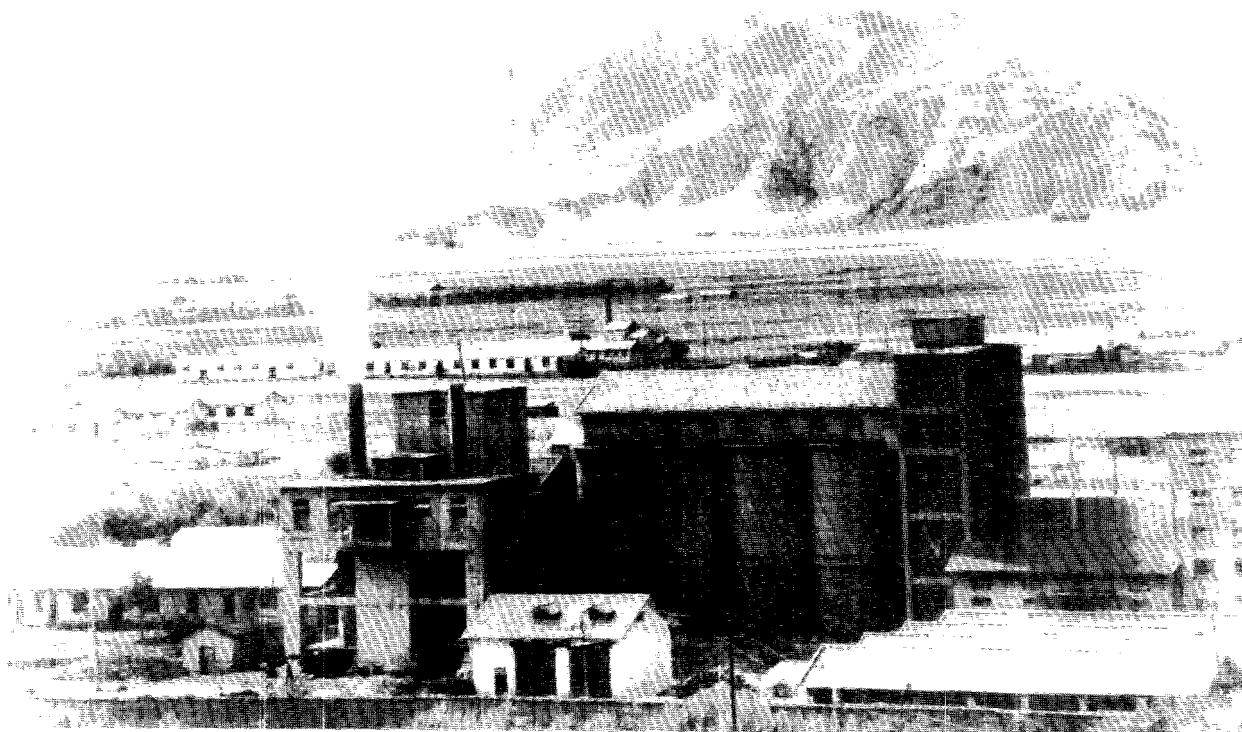
About 60% of China's output of all varieties of fertilizer, in terms of gross weight, is derived from small plants. In terms of effectiveness, the output of small nitrogen fertilizer plants should be discounted by about 25% relative to that of large plants. Ammonium bicarbonate, the chief product of small nitrogen fertilizer plants, is an inferior fertilizer that is not used much outside of China. It decomposes easily; poor storage facilities have contributed to unusually rapid decomposition. By the time it is applied to the fields, it probably contains only about 15% nitrogen. Nitrogen fertilizers produced in China's modern plants have an average nitrogen content of 20% or more. The product from the small phosphate plants also is inferior to that from large plants because it is not absorbed into the soil as readily.

Attempts are being made to modify the small plants to use local fuels so they will not compete with large fertilizer plants for hard coal and coke. Recent orders for 13 large nitrogen fertilizer plants from the West indicate that large plants will overshadow small plants even more by the end of the 1970s.

The standardized small fertilizer plants are equipped mainly by large machinery plants. More than 400 factories of all sizes in Shanghai are making equipment for small chemical fertilizer plants. According to the Chinese press, in 1970-72 Shanghai provided "300 sets of key equipment for these plants, including 25,000 pieces of machinery, motors with a total capacity of several hundred thousand kilowatts, various kinds of instruments and meters, and high- and middle-pressure valves."

#### Cement

Small cement plants in China use stationary vertical-shaft kilns, whereas large plants use rotary kilns. Small plants range in capacity from several thousand tons per year to a maximum of about 32,000 tons. The



32,000-Ton Cement Plant

annual capacity of large plants goes as high as 900,000 tons.

The 32,000-ton small plants use 16,000-ton kilns of a standard design developed by a central design institute in the late 1950s. This type of small cement plant requires grinders, crushers, and other machinery produced by provincial or central factories, machinery that sometimes must be shipped over long distances at considerable expense.

A second kind of small cement plant is the "small-native-mass" type that proliferated during the Leap Forward movement and following the Cultural Revolution. These plants, which vary greatly in size and quality of output, use improvised or hand-me-down machinery; no machinery is obtained from central sources.

Peking claims that output of small plants accounted for 50% of cement production in 1973. This claim appears reasonable. Estimated production from small plants and modern plants is shown in the following tabulation:

	Million Metric Tons		
	Small Plants	Modern Plants	Total
1957	1.0	6.9	7.9
1958	1.4	9.3	10.7
1959	1.7	10.6	12.3
1960	3.0	9.0	12.0
1961	1.9	6.0	7.9
1962	1.5	5.6	7.1
1963	2.4	6.9	9.4
1964	2.2	9.0	11.2
1965	4.0	11.2	15.2
1966	4.5	12.9	17.4
1967	3.7	11.0	14.6
1968	4.2	11.3	15.5
1969	6.1	13.0	19.1
1970	6.4	13.3	19.7
1971	9.2	13.8	23.0
1972	13.6	14.8	28.4
1973	15.4	15.4	30.8

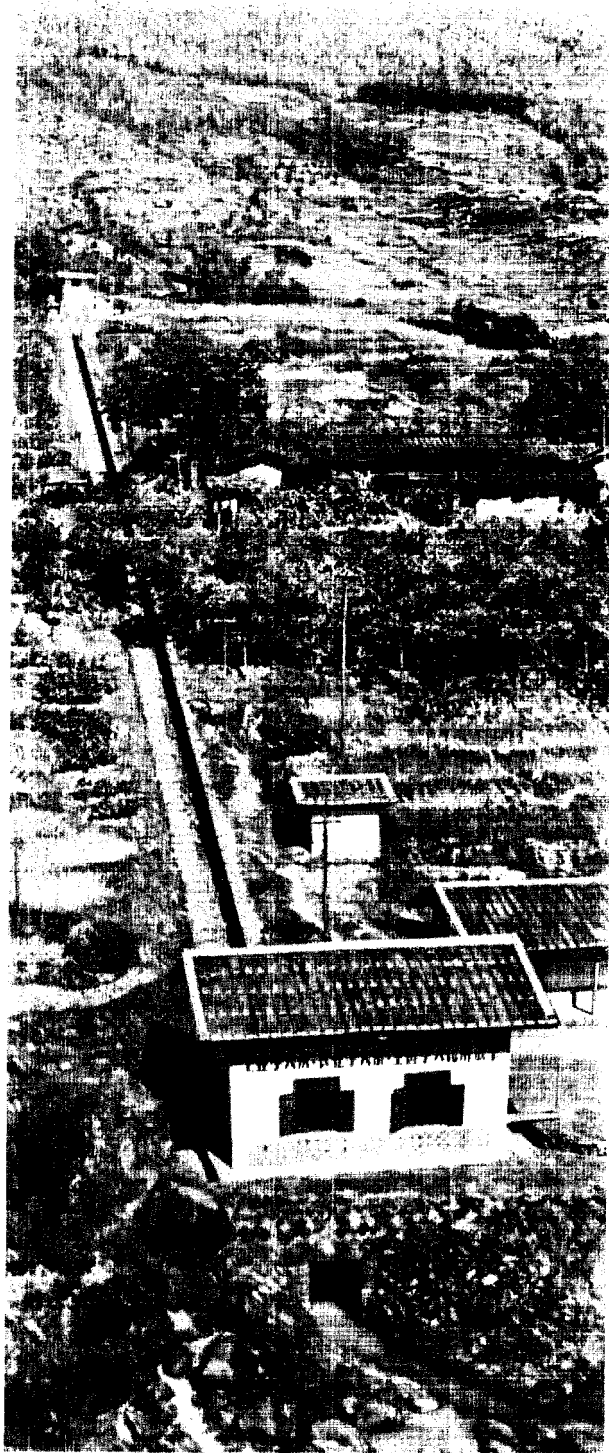
Under the Leap Forward, hundreds of small cement plants sprang up in rural areas, with output scheduled to soar to 5 million tons in 1960. This target was not reached. After the collapse of the Leap, these jerry-built plants were shut down. Production was confined to modern plants and small plants with comparatively modern equipment. This program was not revived on a massive scale until 1968-69, during the final phases of the Cultural Revolution. Press reports in late 1972 maintained that there were about 2,400 small cement plants in China, an increase of 600 from the 1,800 small plants claimed in 1971.

Cement is a high-tonnage item. Localized production helps reduce the burden on China's transport system. Cement from small plants is suitable for most rural construction purposes; the output of large modern cement plants can be largely ticketed for advanced industrial and military construction. Agricultural projects use 70% to 80% of the local cement. These projects include simple bridges, small hydropower stations, grain drying courts, granaries, water tanks, hog pens, houses, telephone poles, and water conservation projects.

In some cases, standardized small cement plants have been in use for over 10 years. The primitive "native" plants are probably being phased out as the number of standardized plants expands. Their product is not worth the cost in fuel and raw materials.

#### Hydroelectric Power

In the 1950s the new Chinese government built only large, modern powerplants, in the Soviet manner. In the frenzy of the Great Leap Forward, the construction of numerous small power stations was undertaken; by the end of 1960, China had 520,000 kilowatts (kw) of rural hydropower capacity, compared with about 20,000 kw at the beginning of 1958. Most of the small power stations were scrapped in the early 1960s, and by 1966 probably less than 200,000 kw remained in service. Policy reverted to distributing power from the large central stations into the rural areas. Large power distribution systems were developed in such areas as the Yangtze River delta, the Pearl River delta, and the Tung-ting Lake area. Nonetheless, the task was so enormous that only a fraction of China's rural area was adequately supplied.



Small Hydroelectric Plant

After the Cultural Revolution, China again turned to widespread installation of small generators in numerous local powerplants. These plants, most of which are hydro-powered, range in size from about 1 kw to about 1,000 kw, with an average size of about 30 kw.

By the end of 1973, 50,000 rural hydroelectric plants had been built with a total capacity of about 1.5 million kw. Small steam and diesel powerplants also number in the thousands; their capacity is at least as great as that of rural hydroelectric plants. These latter are often isolated stations, which provide power to a single user such as mines or small factories. Local plants probably provide nearly 15% of national electric power capacity. Most of these plants are used only about 1,000-2,000 hours annually, compared to 4,000-6,000 hours for large modern plants. Thus, small plants produce perhaps 5 billion kilowatt-hours, or about 5% of national power output. Capacity of rural hydroelectric plants is shown in the following tabulation:

Million Kilowatts			
	Rural Hydro- electric Plants	Modern Powerplants	Total
1957	0.02	4.5	4.5
1958	0.13	6.2	6.3
1959	0.40	9.1	9.5
1960	0.52	10.4	10.9
1961	0.4	11.3	11.7
1962	0.3	11.8	12.1
1963	0.2	12.4	12.6
1964	0.2	12.8	13.0
1965	0.2	13.5	13.7
1966	0.2	17.3	17.5
1967	0.2	19.6	19.8
1968	0.2	20.6	20.8
1969	0.3	23.7	24.0
1970	0.6	25.0	25.6
1971	1.0	25.3	26.3
1972	1.4	26.0	27.4
1973	1.5	27.3	28.8

About 80% of the electricity used on China's farms is for irrigation and drainage. In South China, small hydroelectric stations are an important source of power for flooding the rice paddies. In North China, 1.2 million



Installing a Pipe for a Hydroelectric Plant

power-operated wells had been built by the end of 1973, and many of these receive their power from small plants. The main source of power for major irrigation and drainage systems—for example, in the deltas of the Yangtze and Pearl Rivers—are the large central stations.

Other important users of the power from small rural electric stations are local industrial plants, radio diffusion networks, and electric lighting, which the peasants are permitted to install in meager amounts (bulbs of 10-15 watts are common).

The small powerplants are built largely with local labor and construction materials. Sometimes, salvaged generating equipment is used. The plants require little copper for power transmission. The peasant can readily understand their construction and operation. These plants make use of power sources—especially small streams—that could not provide power in any other way; in many instances, they represent a bonus use of dams required for flood control and water conservation. On the other hand, the small power stations are unreliable and technically inefficient. Streams supplying small hydroelectric plants are often inadequate during dry spells when energy for irrigation pumps is in greater demand. Moreover, although first costs are low, outputs are low too, and the investment cost per kilowatt is about double that of large power stations. Thus their justification rests on savings in transmission costs, the low opportunity costs of resources used in their construction, and the fillip they impart to the peasant's acquaintance with modern technology.

#### Coal

Small coal mines administered by local units probably number nearly 100,000. Production in 1973 is estimated at 115 million tons, about 30% of total coal production. A small mine is usually little more than a small open pit, or a shaft, producing less than 1,000 tons of coal a year. A few "small" mines may produce as much as 100,000 tons annually. Many small mines are run part time by production teams in the off season. The following tabulation shows production from small mines:



Small Strip Coal Mine

	Million Metric Tons		
	Small Coal Mines	Modern Coal Mines	Total
1957	36	95	131
1958	73	157	230
1959	100	200	300
1960	80	200	280
1961	50	120	170
1962	40	140	180
1963	40	150	190
1964	40	160	200
1965	45	175	220
1966	50	190	240
1967	45	145	190
1968	42	163	205
1969	57	201	258
1970	75	235	310
1971	85	250	335
1972	100	257	357
1973	115	263	378

Small mines contributed more than one-third of the astounding increase in coal production during the Leap Forward, when output more than doubled, from about 130 million tons in 1957 to about 300 million tons in 1959. In 1962, most of the small pits were closed as part of the general retrenchment in production. Small mines used lavish amounts of rural labor, constituted in the aggregate a substantial drain on equipment and supplies, and often turned out a notoriously poor quality of coal. The larger of the small mines continued to operate and to be improved throughout the 1960s. In 1969-70 a new drive was started to construct small mines. Many of the mines opened in 1969-70 are being expanded and improved, and output is increasing even though construction of new small mines has waned in the last three years.

Small mines have the advantage of low capital requirements, speed of construction, and saving of transport. For example, one mine is reported to have started with "46 miners, a few shovels, and several dirt baskets." Without any state aid, the workers at this mine went on to make their own equipment and tools. The mine now has 16 shafts and is said to produce 65,000 tons of coal annually.

Small mines usually take less than a year to design, build, and put into operation. A large number of the new small mines have been built south of the Yangtze River where coal previously was shipped from North China. Not all areas have coal deposits, and coal of different types is needed for various industrial processes. Thus some coal must still be shipped considerable distances.

Household use, mostly for cooking, accounts for a substantial portion of local coal. It effectively replaces wood or grass in firing bricks, tile, and lime. Other local industry, particularly cement and metallurgy, depends on the output of small coal mines. A movement is now under way to use local coal in small nitrogen fertilizer plants. In May 1973, 300 small nitrogen fertilizer plants had been renovated to use local coal and charcoal.

Small coal mines are inappropriate where the veins are deeply imbedded or where underground water is a major problem. Where deposits are shallow, the rate of production often falls rapidly after two or three years as easily accessible coal is exhausted. The mines must then either be shut down or mechanical equipment must be

installed to continue operations to greater depths. As more mechanical equipment is needed, capital and operating costs tend to rise and small-scale mining is no longer economically feasible. Cave-ins and accidents occur frequently in small mines because of inadequate pumping equipment, shortages of pitprops, poor ventilation, technical incompetence of workers and cadre, and the shortcut style of operation.

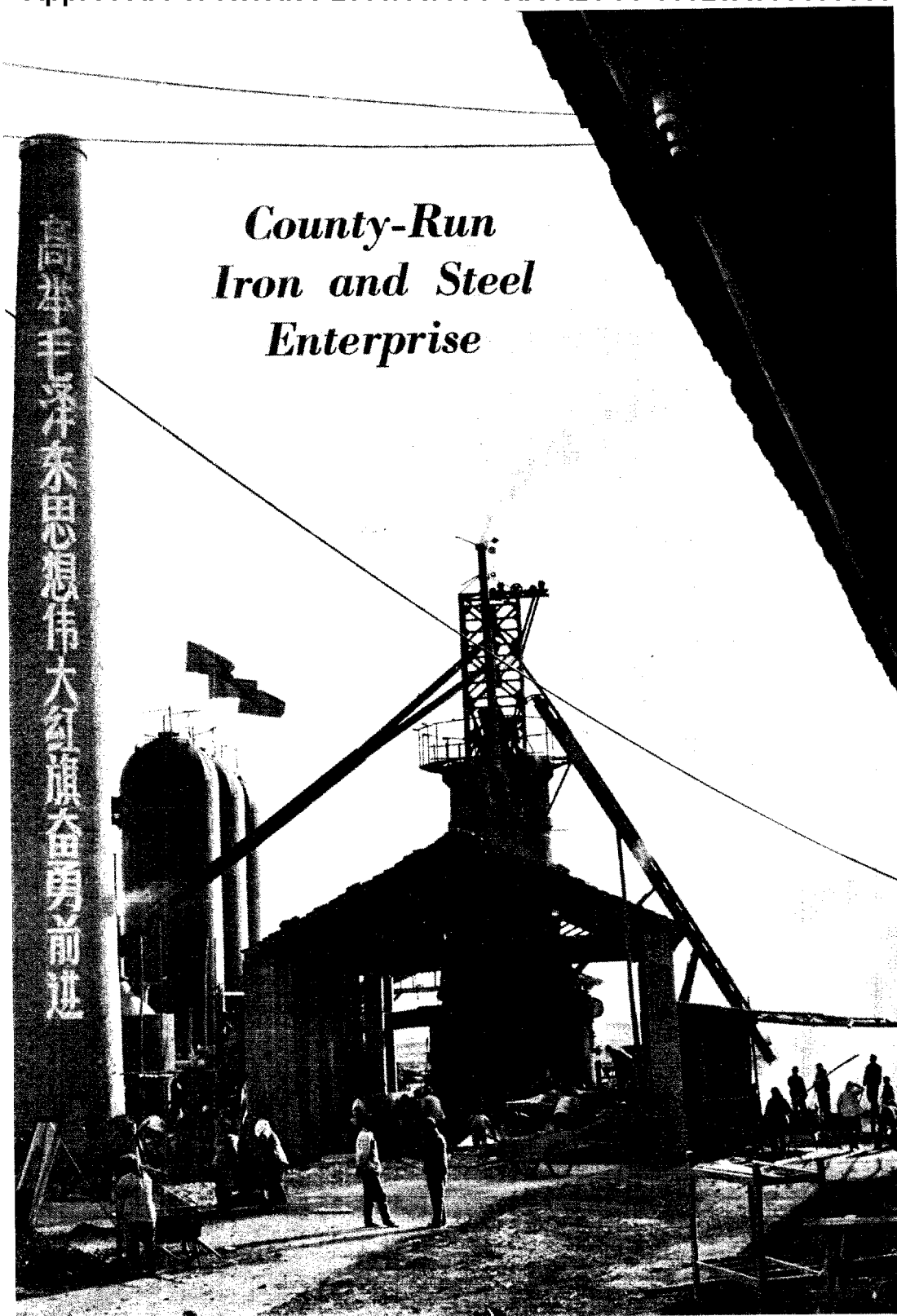
### Iron and Steel

Small iron and steel plants range from the 600,000 backyard furnaces\* of the Leap Forward to fairly modern units using basic oxygen mini-converters and continuous casting machines. Nearly one-half of China's pig iron and almost 30% of its steel were produced by local plants in the peak year 1960. After a sharp cutback in the post-leap period, small plants have made a comeback since 1968; production in 1973 accounted for 20% and 15%, respectively, of total pig iron and steel production. The following tabulation shows production of pig iron and crude steel from small plants:

Million Metric Tons						
	Pig Iron			Crude Steel		
	Small Plants	Modern Plants	Total	Small Plants	Modern Plants	Total
1957	Negl.	5.9	5.9	Negl.	5.4	5.4
1958	4.1	9.6	13.7	3.0	8.1	11.1
1959	9.6	10.9	20.5	3.4	10.0	13.4
1960	13.4	14.1	27.5	5.4	13.0	18.4
1961	Negl.	9.0	9.0	Negl.	8.0	8.0
1962	Negl.	9.0	9.0	Negl.	8.0	8.0
1963	Negl.	10.0	10.0	Negl.	9.0	9.0
1964	Negl.	11.0	11.0	Negl.	10.0	10.0
1965	Negl.	12.5	12.5	Negl.	11.0	11.0
1966	Negl.	14.5	14.5	Negl.	13.0	13.0
1967	Negl.	12.0	12.0	Negl.	10.0	10.0
1968	Negl.	14.0	14.0	Negl.	12.0	12.0
1969	1.0	16.0	17.0	Negl.	15.0	15.0
1970	3.6	15.9	19.5	2.5	15.5	18.0
1971	4.6	19.4	24.0	3.0	18.0	21.0
1972	6.0	21.0	27.0	3.5	19.5	23.0
1973	6.0	23.0	29.0	3.9	22.1	26.0

\* The backyard furnaces were quickly abandoned and are not covered in the remaining discussion of small plant technology.







The blast furnaces in small plants range in capacity from a few thousand tons of pig iron up to 125,000 tons annually. The typical small blast furnace, which has primitive blowing equipment and skip hoists and low-quality furnace linings, produces less than 10,000 tons of pig iron per year.

In the 1950s, local plants largely relied on side-blown converters for steel making. They are small and inexpensive and their frequent heats are especially suited to small bar mills and to foundries making steel castings. The high nitrogen content of steel produced in converters causes it to be more brittle and less easily worked than open hearth steel. Converters also have difficulty removing impurities such as sulfur and phosphorus, which are common in pig iron from small native blast furnaces. Some of the early local plants had electric furnaces as well as converters. Today, side-blown converters and electric furnaces are still in use, but, in addition, some 40 converters similar in operation to the modern basic oxygen furnace have been installed.

At least two of the new small steel plants have installed continuous casting equipment to supply billets for the finishing mills, thus eliminating the need for ingot casting and soaking and for blooming mills. Most plants use extremely simple finishing equipment to produce small bars, sheets, light rails, wire, and tubes.

The steel produced by small plants is used mainly for local construction and for production of farm tools. More complex machinery, including some agricultural machinery, requires higher grade steels than those ordinarily produced in small plants. Small plant output allows large steel plants to devote most of their activity to support of modern industry, transportation, and construction.

Small steel plants face severe problems of quality control. Much of the iron ore used is produced locally and varies widely in grade. Attempts to use local coal as a substitute for coking coal have not been fruitful, so coking coal often must be transported from distant points and the small plants must compete with large plants for tight coking coal supplies. Equipment limitations add to the difficulty of producing a product of uniform quality with a small percentage of impurities. The products made of steel from the small plants tend to wear out more quickly and to be bulkier and heavier than those made of steel from large plants.

### Transportation Equipment

Types of transport equipment produced in local plants include trucks, bicycles, carts, and boats of various kinds, including concrete boats. Some jurisdictions report the production of ball bearings, mainly for use in carts and other simple equipment.

Most of the small truck plants produce only a few trucks each year, and many are motor vehicle repair shops or parts producers. The trucks apparently are used locally in the province or in an area near the plant.

### Electronic Products

Since the Cultural Revolution, attempts have been made to establish small-scale electronics production facilities at the local level. At least 1,000 of these plants have been established throughout the country. Local electronics plants, both in urban and rural areas, may now account for about 5% of total national electronics output.

Two types of small production facilities are involved—urban plants employing as many as 500 employees and rural plants usually employing fewer than 50 persons. The urban plants normally are associated with major electronics plants and receive production equipment as well as technical assistance from the major plants. The function of the urban plants is to supply the parent plant with materials such as monocrystalline silicon and germanium and with components. Occasionally, small urban plants produce finished products for local and state consumption. Rural plants, in contrast, often fabricate their own production equipment and usually produce simple products such as resistors, capacitors, and radios for local consumption. Their products meet lower specifications than the products of the urban local plants.

The program has had some success in expanding electronic products to both urban and rural consumers. In 1973, at least 150 small plants produced transistor radios for local sale. Moreover, the urban plants have become important sources of input materials and products for major electronics plants. At the same time, the program is plagued with problems of non-standardized products, wasted raw materials, and shortages of skilled labor.

### **Light Industries**

The expansion of light industry is considered an essential ingredient in the drive for self-sufficiency. Traditionally, substantial amounts of China's sugar, flour, and paper have been produced in small plants. Most traditional handicraft products such as art goods, metal ware, and pottery, as well as "items of everyday use", such as thermos jugs, flashlights, and batteries are produced in small shops. Also much of home produc-

tion—sewing, tanning, straw weaving, carpet weaving, shoe making, and the like—has been incorporated into the local small plant system, a natural development of increased specialization.

For the purposes of this report, these light industries are not part of the "small plants program" because they do not share with the industries described above the deliberate massive infusion of new technology into the countryside.